Waves	EM spectrum and polarisation: further work

Learning objectives	MUST (C)	Recall polarisation characteristics, and explain how microwaves can be polarised
	SHOULD (B)	Describe the communication applications of polarisation
	COULD (A/A*)	Derive and/or apply Malus' law to polarising filters.

STARTER: Think about these regions of the EM spectrum. What makes them suitable for the given use or application?

Microwaves - heating food

Microwaves - communications with satellites

Radio waves - communications

EXTENSION: Our ancestors were able to see UV light, and some limited other vision. At some point between 80 and 30 million years ago, we evolved to see what we now call 'visible' light. What advantage do you think this conferred?

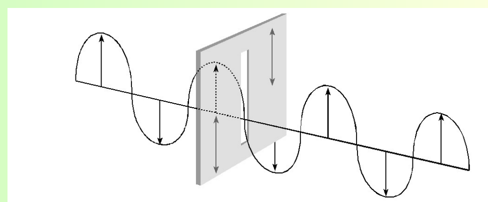
Waves	**EM spectrum and polarisation - further work**
MUST (C)	Recall polarisation characteristics, and explain how microwaves can be polarised

Characteristics of polarised light:

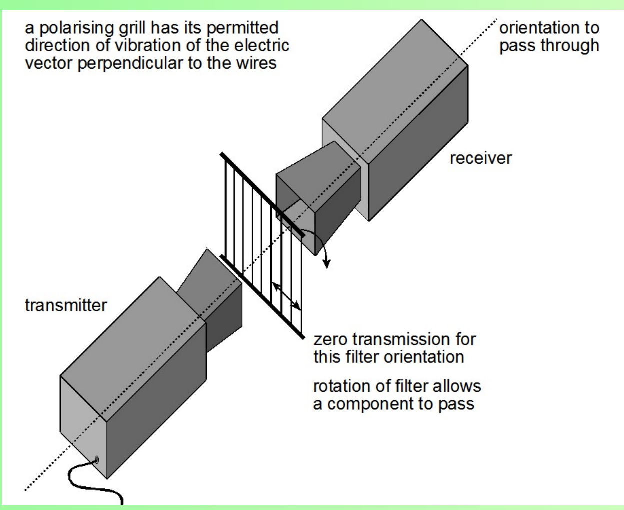
- When unpolarised light passes through a polarising filter, it only permits it to oscillate in one plane.
- Only possible in transverse waves.
- Two polarising filters in the same orientation: maximum transmission of light. Two filters at right angles: minimum transmission

Would the same polarising filter work for microwaves? Why, or why not?

The success of a polarising filter depends upon the size of the gap relative to the wavelength of the wave being polarised.



To polarise microwaves, a metal grille can be used with spacing of approximately 1 cm.



Microwave transmitters usually emit plane polarised waves: the grille only allows those oscillating in one direction to pass through.

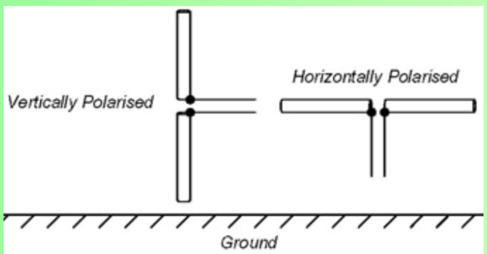
Which orientation will pass through?

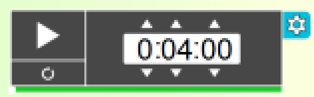
Waves that oscillate **at right angles to the wire** will pass through. Why?

Energy is absorbed by the wires that are parallel to the oscillation direction.

Waves	**EM spectrum and polarisation - further work**
SHOULD (B)	Describe the communication applications of polarisation

Radio waves for communication are produced as plane polarised waves.





a) What orientation does the receiver have to be in?

The same orientation as the transmitter.

b) Why can polarising the signals be useful?

If two transmitters are close - one horizontal and one vertical can prevent interference of signals. Possibility for two different signals on the same frequency channel.

c) What else can potentially affect the polarisation of radio waves?

Bouncing off the ground or ionosphere (effects depend upon wavelength/ distance/orientation)

Waves	**EM spectrum and polarisation - further work**
COULD (8/9)	Derive and/or apply Malus' Law to polarising filters

Malus' Law states that the light transmitted through two polarising filters is:

$$I_{trans} = I_0 \cos^2\theta$$

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where I_{trans} is the transmitted intensity, I_0 is the original intensity, and θ is the angle between the transmission axes of the two filters (if they were lined up, θ = 0)

Tasks (choose two. If you finish, keep choosing...):

- Derive Malus' Law.
- Find the fraction of transmitted light for θ = 30°, 45°, and 60°
- Sketch a graph of the transmitted radiation against θ for θ = 0 to 180
- Explain qualitatively why three filters - two at right angles, and one at 45° in the middle - will transmit some light, when the two at right angles have full extinction.
- Calculate how much light would be transmitted in the example above.

Deriving Malus' Law:

A polariser is placed at an angle of θ° to another polariser. Only the component parallel to its plane of transmission goes through, and so its amplitude is reduced to $A = A_0 \cos\theta$. The intensity is the amplitude squared and so:

$A^2 = A_0^2 \cos^2\theta$, which is $I = I_0 \cos^2\theta$

Waves	**EM spectrum and polarisation: further work**

Learning objectives	**MUST (C)**	Recall polarisation characteristics, and explain how microwaves can be polarised
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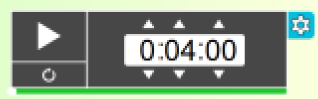
PLENARY: Why do some animals/fish/birds have the ability to detect polarized light? (Think of the evolutionary advantage).
What evolutionary advantages could there be to detecting other parts of the EM spectrum?



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